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Traumatic epistaxis: Skull base defects, intracranial complications and neurosurgical considerations

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ABSTRACT

INTRODUCTION: Endonasal procedures may be necessary during management of craniofacial trauma. When a skull base fracture is present, these procedures carry a high risk of violating the cranial vault and causing brain injury or central nervous system infection.
PRESENTATION OF CASE: A 52-year-old bicyclist was hit by an automobile at high speed. He sustained extensive maxillofacial fractures, including frontal and sphenoid sinus fractures (Fig. 1). He presented to the emergency room with brisk nasopharyngeal hemorrhage, and was intubated for airway protection. He underwent emergent stabilization of his nasal epistaxis by placement of a Foley catheter in his left nare and tamponade with the Foley balloon. A six-vessel angiogram showed no evidence of arterial dissection or laceration. Imaging revealed inadvertent insertion of the Foley catheter and deployment of the balloon in the frontal lobe (Fig. 2). The balloon was subsequently deflated and the Foley catheter removed. The patient underwent bifrontal craniotomy for dural repair of CSF leak. He also had placement of a ventriculoperitoneal shunt for development of post-traumatic hydrocephalus. Although the hospital course was a prolonged one, he did make a good neurological recovery.
DISCUSSION: The authors review the literature involving violation of the intracranial compartment with medical devices in the settings of craniofacial trauma.
CONCLUSION: Caution should be exercised while performing any endonasal procedure in the settings of trauma where disruption of the anterior cranial base is possible.

Numerous reports have described the inadvertent violation of the intracranial compartment by nasogastric and nasotracheal tubes in the setting of skull base trauma. Blind endonasal procedures in this setting may be associated with severe complications,[1,2] but may become necessary with severe epistaxis. Here we describe a case in which a urinary Foley catheter was inserted and inadvertently deployed intracranially during an attempt to control life-threatening posterior nasal hemorrhage with balloon tamponade.

1. Case presentation

A 52-year-old male bicyclist was transported to our facility following collision with a motor vehicle. Because of brisk nasopharyngeal hemorrhage, he was intubated for airway protection. The patient's eyes remained closed due to diffuse facial swelling and periorbital edema, but he was alert and following commands in all extremities. Computed tomography demonstrated extensive maxillofacial fractures, including fractures of the cribriform plate, frontal and sphenoid sinuses and clivus, with bilateral contusions, extra-axial hemorrhage at the vertices, extensive subarachnoid hemorrhage in the basal cisterns, and diffuse cerebral edema (Fig. 1).

A Foley catheter was placed emergently in the left nare for balloon tamponade of the nasopharyngeal hemorrhage. A six-vessel angiogram showed no evidence of arterial dissection or laceration. Follow-up imaging demonstrated inflation of the Foley catheter balloon tip in the frontal lobe (Fig. 2). The balloon was subsequently deflated and the Foley catheter removed. Patient underwent bifrontal craniotomy for dural repair of CSF leak. He also had placement of a ventriculoperitoneal shunt for development of post-traumatic hydrocephalus. Although his hospital course was a prolonged one, he did make a good neurological recovery.

2. Methods

A separate PubMed and GoogleScholars search (1970-current) for the keywords – *Foley catheter, nasogastric tube*, and *nasotracheal tube* – combined with the search terms *craniofacial trauma, intracranial*, and/or *brain* and limited to *humans* was conducted. Collectively, these searches resulted in 33 reports published in the

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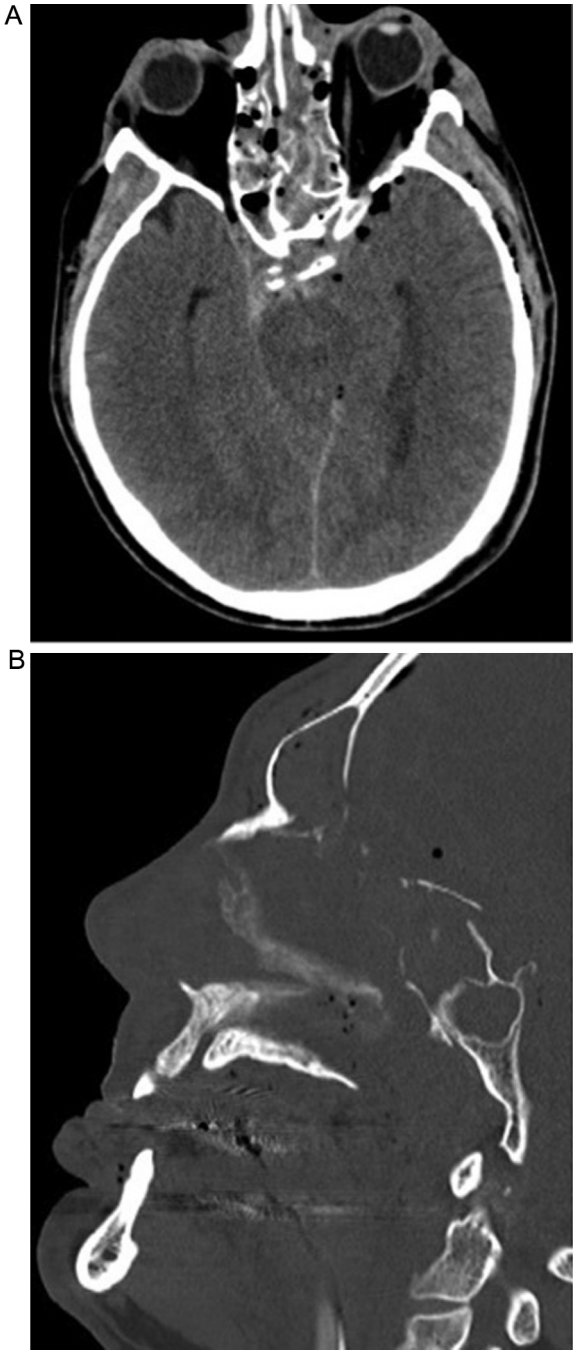

Fig. 1. (A) Axial non-contrast head CT demonstrating traumatic pneumocephalus and intracranial hemorrhage. (B) Sagittal reconstruction of non-contrast thin-cut head CT demonstrating fractures of the cribiform plate, and frontal and sphenoid sinuses.

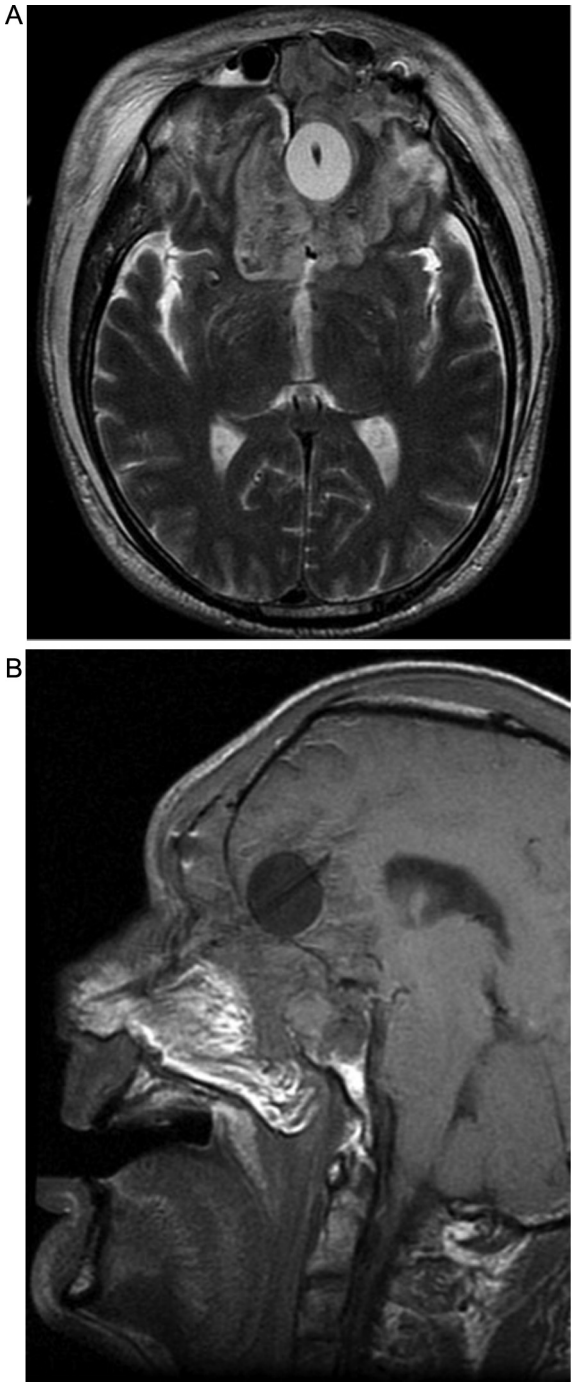

Fig. 2. (A) Axial T2-weighted MRI demonstrating Foley catheter balloon in the left frontal lobe with bifrontal contusions and edema. (B) Sagittal T1-weighted MRI demonstrating balloon deployed superior to the skull base defect.

English language. The characteristics of each patient's case and clinical outcomes are detailed in Table 1.

3. Discussion

Previous reports have recommended that posterior nasal packing not be performed in the presence of facial trauma that may include nasal bone and cribriform plate fractures.[3–5] However, severe epistaxis associated with craniofacial trauma often necessitates nasal packing with the use of balloon systems or even arterial embolization/ligation. As evidenced by this report and four previous case reports,[6–9] skull base fractures pose an inherent risk for the inadvertent intracranial placement of medical devices.

Extensive facial trauma is often associated with fractures to the skull base, cribriform plate, and sphenoid sinus. As shown in Table 1, a fractured or deformed cribriform plate is the most common site of intracranial breach for a misguided Foley catheter, nasogastric tube, and nasotracheal tube. The attempt to intubate these patients is complicated by epistaxis and craniofacial deformity, which compromises airway visualization. Intracranial penetration is possible without much difficulty or awareness if the cribriform plate and/or anterior cranial fossa is fractured and the dura mater is lacerated. As stated by Baskaya et al. there are four possible pathways by which

Table 1
Reported cases of cranio-facial trauma, misguided intracranial placement of tubes, sites of penetration, intracranial complications, method of retrieval, and clinical outcome.

#	Year	Author (reference)	Age/sex	Cause of Trauma	Site of intracranial penetration	Instrument	Site of intracranial complication	Neurosurgical retrieval?	Manual retrieval?	Clinical outcome
1	1975	Seebacher et al. [27]	17 F	Motor vehicle accident	Cribriform plate	NGT	N/A	N	Y	Decreased mental status; right hemiparesis; Death
2	1977	Wyler et al.[26]	34 W	Fall from height	Cribriform plate	NGT	N/A	N/A	N/A	Death
3	1978	Bouzarth[28]	N/A	N/A	N/A	NGT	N/A	N/A	N/A	N/A
4	1978	Gustavsson et al. [29]	N/A	Auto-pedestrian accident	N/A	NGT	N/A	N/A	N/A	Lived, loss of vision and smell
5	1978	Horellou et al.[30]	N/A	Severe head trauma	N/A	NTT	N/A	N/A	N/A	Death
6	1978	Gregory et al.[31]	N/A	Struck in face by car tire rim	N/A	NGT	N/A	N/A	N/A	Discharged on 14th postoperative day; Lived with no major complications
7	1978	Fremstad et al.[32]	N/A	Motor vehicle accident	N/A	NGT	N/A	N/A	N/A	Death
8	1979	Galloway et al.[33]	28 M	Motorcycle accident	Cribriform plate	NGT	N/A	N/A	N/A	Pneumocephalus; death 3 days after admission
9	1981	Borovich et al.[34]	N/A	Blunt trauma	N/A	NGT	N/A	N/A	N/A	Death
10	1981	Borovich et al.[34]	N/A	Motor vehicle accident	N/A	NGT	N/A	N/A	N/A	Lived
11	1983	Moustoukas et al.[35]	76 M	Motor vehicle accident	N/A	NGT	Left hemisphere	N/A	N/A	Death
12	1987	Fletcher et al.[22]	N/A	Motor vehicle accident	N/A	NGT	N/A	Craniotomy	N	Lived with left hemiparesis
13	1987	Fletcher et al.[22]	N/A	Gunshot wound	N/A	NGT	N/A	Craniotomy	N	Lived with left hemiparesis
14	1989	Koch et al.[36]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	1992	Adler et al.[37]	26 M	Gunshot wound	Cribriform plate	NGT	Looped in interhemispheric fissure and reflecting back into dorsal midbrain	N	N/A	Death
16	1993	Cornett et al.[24]	50 M	Electric shock injury	Cribriform plate	NGT	Right cerebral hemisphere with pneumocephalus and extensive hemorrhage along the catheter track	Y, right parietoccipital craniotomy	Y	Left hemiparesis
17	1993	Porras et al.[6]	26 M	Struck in face by machine	Atlanto-occipital dislocation	FC	Spinal canal (C1–C4)	Y	N/A	Death
18	1993	Sacks et al.[25]	N/A	N/A	Anterior cranial fossa	N/A	N/A	N/A	N/A	N/A
19	1994	Katz et al.[38]	N/A	Fall from height	N/A	NGT	N/A	N/A	N/A	Pneumocephalus; death 2 weeks after admission
20	1997	Marlow et al.[39]	29 M	Motor vehicle accident	Cribriform plate	NTT				
21	1998	Castiglione et al.[40]	27 F	Attempted homicide	Ethmoid lamina cribrosa	NGT	Occipital region	All neurosurgical procedures, deemed unsuitable	N	Death
22	1999	Baskaya[5]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
23	2000	Ferreras et al.[4]	38 M	Traffic accident	N/A	NGT	Left frontal lobe	N	Y	No apparent neurologic deficits; resolution of pneumoencephalos
24	2001	Arslantas et al.[41]	3 M	Traffic accident	Cribriform plate	NGT	Left frontal lobe	N	Y	Dural repair for rinorrhoea and was discharged in good health
25	2003	Pawar et al.[8]	50 M	Pedestrian hit by car	Left posterior ethmoidal-anterior part of the sphenoidal sinus	FC	Rightsubfrontal lobe, lateral ventricular cavity, left occipital lobe	N	Y	Death

Table 1 (*Continued*)

#	Year	Author (reference)	Age/sex	Cause of Trauma	Site of intracranial penetration	Instrument	Site of intracranial complication	Neurosurgical retrieval?	Manual retrieval?	Clinical outcome
26	2004	Genu et al.[3]	53 M	Motorcycle accident	Cribriform plate	NGT	Posterior cranial fossa	N/A	N/A	Hemiplegia of the right arm and leg; underwent a surgical procedure to treat a chronic frontal subdural hematoma' discharged with neurologic complications
27	2004	Pandey et al.[42]	35 M	Motor vehicle accident	Laminacribrosa of the ethmoid bone	NGT	Left parietal region	N	Y	Death
28	2005	Rahimi-Movaghar et al.[43]	34 M	Falling from height	Ethmoid lamina cribrosa	NGT	Both hemispheres	N/A	N/A	Death
29	2008	Woo et al.[9]	64 M	Motorcycle crash	Ethmofrontal	FC	Left frontal lobe	N	Y	Death
30	2010	Chandra et al.[44]	45 M	Motor vehicle accident		NGT		N	Y	Death
31	2010	Roka et al.[45]	55 M	Head injury due to a corn thrasher	Fractured anterior cranial fossa floor	NGT	Left hemisphere			Bilateral severe edema, effacement of basal cisterns, loss of gray matter–white matter interface and resolving hematoma along the NG tract on the left side; death on day 6
32	2011	Huang et al.[7]	45 M	Motorcycle crash	Anterior ethmoidal sinus	FC	Left basal ganglia	Y	N	Intracranial hematoma; patient recovered without significant neurological deficits
33	2012	Reported case	52 M	Bicyclist hit by automobile	Frontal and sphenoid sinus fractures	FC	Frontal lobe	N	Y	Bifrontal craniotomy for dural repair of CSF leak; good neurological recovery

FC = Foley catheter; NGT = nasogastric tube; NTT = nasotracheal tube; N/A = not available.

a tube can enter the intracranial compartment: a skull base fracture extending across the cribiform plate, a comminuted fracture involving the floor of the anterior cranial fossa, an unusually thin cribiform plate and a cribriform plate thinned by sinusitis.[5]

Inadvertent introduction of nasogastric tubes in the cranial cavity have also been described in non-trauma settings, particularly in association with certain congenital or acquired conditions. A marked septal deviation, underdevelopment of the turbinates, and a high-grade pneumatization of the paranasal sinuses may favor false passage of a nasogastric tube.[10] Nathoo et al. report such a case in a neonate in which a nasogastric tube was inserted intracranially following repair of unilateral chondral atresia.[11] In a case of a patient with Teacher-Collins syndrome, the authors describe bilateral bony choanal atresia as the root cause of the misplaced rubber tube. In this particular patient, the soft rubber tubing created a linear hemorrhagic tract coursing through the anteroinferior basal frontal lobe, thalamus and basal ganglia and terminating in the occipital lobe. The patient subsequently developed bacterial meningitis and communicating hydrocephalus followed by cerebrospinal fluid rhinorrhea.[12] Freij and Mullet report a patient with unremitting status epilepticus in whom a nasogastric tube passed via a congenital defect in the fronto-ethmoidal region that communicated with the roof of the nasal cavity.[13] At least three reports describe inadvertent intracranial penetration of a nasogastric tube in patients who had or were undergoing surgery to remove pituitary tumors via the transphenoidal technique.[14–16] Other reports of intracranial nasogastric tubes in non-trauma settings include that of a premature infant with acute respiratory distress syndrome in whom intubation had been performed to decompress the stomach[17], a patient with recurring episodes of hemesis[18], a patients with Goldrenhar syndrome associated with cribriform plate agenesis,[19] and one apparently healthy patient who volunteered for a clinical research study on bile secretions.[20] Most recently, a case described the inadvertent placement of a small-bore feeding tube into the brain stem and spinal cord of a patient with a history of previous endoscopic transnasal resection of clival chordoma. The patient did not recover any motor strength, remained quadriplegic, and eventually died seven months later after a prolonged hospital course.[21] In each of these cases, forced or incorrect insertion of a semi-rigid nasogastric tube perforated the ethmoid lamina cribrosa and led to significant morbidity and mortality.

The management of intracranial insertion is removal of the tube under direct observation by craniotomy or by careful retrieval via the nasal route. While some report successful retrieval via craniotomy,[22] others suggest using manual retrieval through the nasal passage as the best approach.[4,13,20] Given the limited number of cases, there is no clear consensus as to which approach is associated with better clinical outcomes.

Due to the significant associated morbidity and mortality, most authors recommend that nasal intubation not be performed when there is reason to suspect fractures of the base of the skull. Oral intubation assisted by laryngoscopic,[23,24] radioscopic, or visual inspection[22,25,26] is recommended. Posterior nasal bleeding with craniofacial injuries should be a relative contraindication for posterior nasal packing with Foley catheter. Instead, endoscopic cauterization, ligation of bleeding vessels, tamponade with a commercially available short hemostatic nasal catheter, or packing with gauze could be used to avert intracranial complications.

In a case where use of these instruments is absolutely critical in an at-risk patient population, the tip of the feeding tube should be visualized directly, endoscopically, or radiographically as it passes from the nose to the esophageal inlet.[21] Nasogastric intubation should be performed only after a cranial CT scan or other radiographic imaging confirms integrity of the anatomic structures dividing the nose-pharynx from the brain parenchyma.[3] If a Foley catheter is the only available treatment for posterior epistaxis, a large sized catheter should be used and insertion should be in a straight direction, parallel to the floor of the nasal cavity with direct visualization along the inferior meatus.[9] Confirmation of the appropriate position of the balloon tip by using a Foley tube filled with contrast medium before nasal packing has also been recommended.[6,7] After inserting the first 10 cm length of Foley catheter, identification of its trajectory and position by the C-arm or portable X-ray may prevent upward migration and iatrogenic complications.[7]

Admittedly, given the dissimilarity of features among case studies in Table 1, it is difficult to isolate the contributions of intracranial tube placement from the primary traumatic events as sources of morbidity and mortality. In each case it is necessary to examine the patient's anatomic features, clinical condition, associated risks and comorbidities, and case-specific circumstances of the event. However, best estimates from earlier reports claim that inadvertent nasogastric tube positioning within the cranial cavity is serious and carries a reported mortality of at least >50%.[22] Also, severe complications may occur in the form of hemiparesis, intracranial bleeding, decerebrate posturing, respiratory arrest, suctioning of brain parenchyma, blindness, loss of the sense of smell, meningitis, decreased mental status, and persistent cerebrospinal fluid fistula.[4,22]

4. Conclusion

Intracranial insertion exacerbates a poor prognosis in the setting of craniofacial trauma. This case highlights the importance of exercising great caution while performing any endonasal procedure in the setting of trauma where disruption of the anterior cranial base is possible.

Conflict of interest

The authors have no commercial or other associations.

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Ethical approval

The patient remains neurologically compromised and was unable to provide direct consent. Written informed consent was obtained from the patient's wife for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contributions

All authors were involved in the writing and editing process of the manuscript preparation.

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